

V. *Experiments and Observations on the Poison of Animals of the Order Araneidea.*By JOHN BLACKWALL, *Esq., F.L.S. &c.*

Read December 19, 1848.

MUCH has been written about the deleterious property of the transparent colourless fluid emitted from the minute orifice situated near the extremity of the fangs of spiders on the side next to the mouth, when those instruments are employed to inflict a wound. The numerous accounts which have been published by various authors of the singular effects induced in the human species by the bite of the Tarantula (*Lycosa tarantula apuliae*, Walck.), and of the still more extraordinary mode of cure, together with the serious and sometimes fatal consequences which have been attributed to the bite of the Malmignatte (*Latrodectus malmignatus*, Walck.), must be regarded as amusing fictions in the natural history of the *Araneidea*; and if the opinion, prevalent among arachnologists of the present day, that insects pierced by the fangs of spiders die almost instantaneously, should be found on examination to be at variance with well-ascertained facts, it must in like manner be deemed fanciful.

For the purpose of testing the validity of this opinion, which I had reason to doubt, and in order to determine with a nearer approximation to accuracy than had previously been done, some of the effects produced under divers circumstances by the poison of spiders, more especially the degree of influence it exercises in destroying the vital functions of animals, in the summer of 1846 I commenced an experimental investigation of the subject, the particulars of which are comprised in the following pages.

To avoid confusion, the experiments have been arranged under four distinct heads, corresponding to the objects upon which they were made; namely, the human species, spiders, insects, and inanimate substances. It may be proper to premise that all the animals were adult individuals in vigorous health, and that the temperature of the atmosphere, in every instance recorded, was ascertained by means of a thermometer graduated according to Fahrenheit's scale, and exposed to the open air in a shady situation having a northern aspect.

1. *Experiments on the Human Species.*

On the 19th of July 1846, a female *Epëira diadema* was induced to bite me on the inner side of the left hand, near the base of the forefinger; it continued to force its fangs deeper into the flesh during a period of many seconds, and at last quitted its hold voluntarily, when a little blood issued from the wounds it had inflicted. Though the spider was in a state of great excitement from previous irritation, yet I did not experience more inconvenience from its bite than from a puncture made near it at the same time with a fine needle; indeed, allowing for a considerable degree of compression in the former case, the effects of both injuries appeared to be very similar. The thermometer, while the experi-

ment was in progress, stood at 76° ; the air throughout the day was sultry, and an extensive thunder-storm occurred in the evening.

A highly exasperated female *Epëira diadema* was allowed to seize me on the inner side of the left fore-arm, near the carpus, on the 30th of July 1846. It continued for more than a minute to bury its fangs deeper in the flesh, and on quitting its hold voluntarily a little blood flowed from the wounded part, near which a puncture was made simultaneously with a fine needle. The air was sultry, the temperature at the time being 75° , and distant thunder was heard. No difference was perceptible between the results of this and the preceding experiment.

At 11^h 30^m A.M. on the 22nd of August 1846, the thermometer at the time indicating a temperature of 65° , a powerful and much-irritated female *Epëira quadrata* bit me on the inner side of the left fore-arm, near the carpus. It retained its hold for the space of five minutes, occasionally forcing its fangs deeper into the flesh, and on quitting it voluntarily blood issued freely from the punctures. Due allowance being made for the strong degree of compression employed by this robust spider, the effects of its bite did not differ materially from those of a wound made near it at the same time with a needle of an average size, the intensity and duration of the pain being very similar in both instances.

On several occasions, in the month of August 1846, spiders of various species were induced, under the influence of excited feelings, to seize a piece of clean window-glass with their fangs, when the transparent fluid which escaped from the small aperture near their extremity was deposited upon it. The application of this fluid to the tongue did not produce any sensible effect on that organ; but the result was very different when the poison emitted under like circumstances from the sting of the common Wasp, *Vespa vulgaris*; the Hive-bee, *Apis mellifica*; or the Humble-bee, *Bombus terrestris*, was so applied, a powerfully acrid pungent taste being the immediate consequence. A contrast equally remarkable was evinced when these fluids were transmitted into a recent wound; that secreted by the insects caused inflammation accompanied by acute pain; effects, which if produced at all by that secreted by the spiders, were scarcely appreciable.

The legitimate conclusion deducible from the experiments seems to be, that there is nothing to apprehend from the bite of the most powerful British spiders, even when inflicted at a moment of extreme irritation and in hot sultry weather, the pain occasioned by it being little, if any, more than is due to the laceration and compression the injured part has sustained.

The manner in which spiders are affected when pierced by the fangs of animals of their own order demands attention in the next place.

2. Experiments on Spiders.

On the 22nd of July 1846, a male *Tegenaria civilis*, in a violent struggle with a female of the same species, deeply inserted his fangs near the middle of the dorsal region of her abdomen, and retained his hold for several seconds; from the punctures thus made a brown fluid issued copiously, and in a few minutes coagulated. The injured spider appeared to suffer very little from the severe wounds it had received, as it speedily constructed a small web in the phial in which it was confined, and continued for more than a year to

feed freely on the flies introduced to it. The thermometer, at the time the experiment was made, indicated a temperature of 74°.

In a hostile encounter between two female spiders of the species *Segestria senoculata*, on the 29th of July 1846, one of them was pierced by the fangs of her opponent on the under side of the abdomen, near the spinners. A transparent colourless fluid oozed from the wounds for many minutes, and ultimately coagulated; but the spider seemed to experience little inconvenience from the injury, being lively in its motions and preying eagerly upon the insects with which it was supplied. The temperature at the time was 76°, and the atmosphere was highly electrical.

A female *Ciniflo atrox* was bitten by an exasperated female *Lycosa agretyca* near the middle of the cephalo-thorax, on the 29th of July 1846, the temperature by the thermometer being 76°. The *Lycosa* retained its hold for many seconds, and on quitting it voluntarily a transparent colourless fluid flowed from the punctures and coagulated. The wounded spider, apparently regardless of the injury it had received, spun a web with which it long continued to ensnare its victims.

On the same day, the mercury in the thermometer denoting a temperature of 75°, a female *Epëira diadema*, in a violent struggle with a female *Cælotes saxatilis*, pierced her abdomen in the medial line of the dorsal region, about a third of its length from the spinners. The wounded spider did not exhibit any marked symptoms of distress and speedily resumed its accustomed habits.

In an attack made by a female *Ciniflo ferox* upon a female *Lycosa agretyca*, on the 30th of July 1846, the temperature being 74°, the latter was wounded by the fangs of its assailant at the base of the coxa of the left posterior leg, and a transparent fluid, which soon coagulated, issued from the injured part. Nothing occurred afterwards to indicate that the *Lycosa* had suffered from the encounter.

Two female spiders of the species *Epëira diadema* engaged in a severe contest on the 30th of July 1846, the thermometer standing at 73°, when one of them was seized by the fangs of her antagonist near the middle of the right side of the abdomen. A brown fluid flowed from the punctures and soon coagulated, but the spider appeared to be only slightly and very briefly affected by the injury.

A female *Epëira diadema*, in a highly excited state, bit itself near the middle of the femur of the left anterior leg, on the 5th of September 1846. The temperature at the time was 69°, and a transparent fluid flowed copiously from the wounded part; coagulation, however, quickly ensued, after which the spider manifested no unfavourable symptom whatever.

Extensive mechanical injuries commonly prove fatal to spiders, whether received in conflicts with their congeners or otherwise, the extinction of life being more or less rapid in proportion to the vitality of the part lacerated; but no evidence supplied by the foregoing experiments indicates that the fluid emitted from the orifice in the fangs of the *Araneidea* possesses a property destructive to the existence of animals of that order when transmitted into a recent wound; in short, it does not appear to exercise any greater degree of influence upon them than it does upon the human species.

I now proceed to show how insects are affected when pierced by the fangs of spiders.

3. *Experiments on Insects.*

1846. August 7th. A female *Epëira diadema* inflicted a severe wound on the mesonotum of a common Wasp, near the base of the right anterior wing, at 11^h A.M., the temperature at the time being 74°. The wasp, though disabled from flying, survived the injury for the space of thirteen hours.

August 7th. At 1^h 30^m P.M., the temperature being 72°, a female *Epëira diadema* pierced a Humble-bee, *Bombus terrestris*, with its fangs near the posterior part of the mesosternum. The wound deprived the humble-bee of the power of flight, but did not terminate fatally till 11^h P.M. on the 10th.

August 8th. Temperature 68°. A female *Segestria senoculata* seized a Flesh-fly, *Musca vomitoria*, near the middle of the tibia of the right posterior leg, and did not quit its hold for several seconds. A transparent colourless fluid issued from the wounds made by the fangs of the spider, but the fly retained the use of its wings, and did not expire till evening on the 10th.

August 13th. Temperature 64°. At 5^h 15^m P.M. a female *Segestria senoculata* inserted its fangs about the middle of the abdomen of a large Green Grasshopper, *Acrida viridissima*, and retained its hold, which it quitted voluntarily, for many seconds. A greenish-yellow fluid flowed copiously from the punctures, yet the insect continued to be lively in its movements, leaping with agility up and down the glass vessel in which it was confined, and ceased not to exist till midnight on the 15th.

August 14th. Temperature 66°. A female *Epëira diadema* pierced a large Green Grasshopper at 4^h 43^m P.M., burying one fang at the base of the antenna on the right side, and the other in the right eye. The spider retained its hold for several seconds, and on quitting it a greenish-yellow fluid issued from the former wound and a dark brown fluid from the latter. Notwithstanding the serious injuries the grasshopper had received, no diminution of its activity was apparent, and it did not expire till afternoon on the 16th.

August 29th. Temperature 69°. At 1^h 22^m P.M. a Hive-bee had its abdomen extensively lacerated near the middle of the left side by a female *Epëira quadrata*. A large quantity of transparent fluid flowed from the wound, but death did not ensue till 3^h 18^m P.M.

September 3rd. Temperature 68°. A common Crane-fly, *Tipula oleracea*, punctured by the fangs of a female *Segestria senoculata*, at 4^h 35^m P.M., about a quarter of an inch from the posterior extremity of its abdomen, survived till 8^h 7^m P.M.

September 7th. Temperature 69°. At 1^h 45^m P.M. a Flesh-fly was bitten by a female *Epëira diadema* on the under side of the abdomen, near its posterior extremity, and a brownish fluid continued to ooze from the wounds till 5^h 18^m P.M. on the 8th, when the fly expired.

September 7th. Temperature 68°. A common Crane-fly was seized near the posterior extremity of the abdomen, at 4^h 54^m P.M., by a female *Epëira quadrata*. A brownish fluid issued from the punctures made by the fangs of the spider, and the existence of the insect terminated at 6^h 9^m P.M. on the 8th.

September 10th. Temperature 64°. Pierced a Flesh-fly through the middle of the left side of the abdomen with a fine needle, at 12^h 14^m P.M.; a transparent fluid issued from the wound, which the fly survived till 4^h 20^m P.M. on the 11th.

September 10th. Temperature 65°. At 1^h 13^m P.M. a common Crane-fly was pierced through the left side of the abdomen, near the middle, with a fine needle; the insect expired on the same day, at 5^h 29^m P.M.

September 10th. Temperature 65°. The point of a strong needle was deeply inserted into the right side of the abdomen of a large Green Grasshopper, near its anterior extremity, at 1^h 20^m P.M. Though the injury was severe, the life of the insect did not become extinct till 7^h 41^m P.M. on the 12th.

September 10th. Temperature 66°. The right side of the abdomen of a common Wasp was penetrated near the middle with the point of a fine needle, at 2^h 5^m P.M.; a transparent fluid oozed from the puncture, and the life of the wasp terminated at 10^h 20^m P.M.

September 18th. Temperature 60°. A male *Tegenaria civilis* deeply inserted its fangs near the middle of the mesonotum of a House-fly, *Musca domestica*, at 10^h 10^m A.M., and retained its hold for more than an hour and a half. The victim continued to manifest unequivocal signs of life till 10^h 44^m A.M., and appeared to sink gradually from mere exhaustion. All the time it was in the grasp of its enemy, with the exception of short intervals, it was perceived to have a slight nodding motion, which was discovered to be caused by the act of deglutition on the part of the spider, a synchronous motion being always observed in the fluid suddenly and copiously propelled into the spider's mouth, and then by degrees reduced in volume in exact proportion to the continuance of the nutation. Whenever the fluid was withdrawn from the mouth a fresh supply was speedily introduced, and after mingling with that extracted from the body of the fly, was conveyed into the stomach of the spider by a repetition of the act of swallowing, thus occasioning the nodding motion with intervals of repose apparent in its prey.

September 18th. Temperature 61°. At 10^h 20^m A.M. a female *Tegenaria civilis* seized a House-fly with its fangs near the middle of the mesonotum, and did not relax its hold for more than an hour. The struggles of the fly became gradually more feeble, till they ceased altogether at 10^h 47^m A.M. The nodding motion of the victim, and all the attendant circumstances, were as conspicuous in this instance as in the preceding one.

September 18th. Temperature 64°. A female *Segestria senoculata* penetrated with its fangs the right side of the mesonotum of a House-fly at 1^h P.M., but did not deprive it of life till 1^h 29^m P.M. The spider kept its hold about an hour; and a nodding motion of the fly, regularly accompanied by the act of deglutition in its destroyer, with brief and simultaneous pauses in both, was observed during the entire period.

1847. July 15th. Temperature 71°. At 5^h 3^m P.M. a brilliant Green Fly, *Musca caesar*, was pierced by the fangs of a female *Agelena labyrinthica* near the posterior extremity of the abdomen, on the under side. After retaining its hold about ten minutes the spider transferred it to the middle of the mesosternum, perforating the part and rapidly extracting the fluids of its prey, whose existence terminated at 5^h 26^m P.M. A nutation of the fly was constantly observed to accompany the action of swallowing in its adversary.

July 19th. Temperature 70°. A female *Agelena labyrinthica* struck its fangs into the left side of the mesonotum of a Flesh-fly, at 12^h 23^m P.M., and eagerly extracted its fluids, the act of deglutition being attended with the usual nodding motion of the victim. After ineffectual efforts to escape the insect became exhausted, and finally expired at 12^h 43^m P.M.

These experiments do not present any facts which appear to sanction the opinion that insects are deprived of life with much greater celerity when pierced by the fangs of spiders than when lacerated mechanically to an equal extent by other means, regard being had in both cases to the vitality of the part injured, as the speed with which existence terminates mainly depends upon that circumstance. It is true that the catastrophe is greatly accelerated if spiders maintain a protracted hold of their victims, but this result is obviously attributable to the extraction of their fluids, which are transferred by oft-repeated acts of deglutition into the stomachs of their adversaries.

From the entire mass of evidence supplied by the experiments taken in the aggregate, it may be fairly inferred that whatever properties characterize the fluid emitted from the orifice in the fangs of the *Araneidea*, it does not possess that degree of virulence which is commonly ascribed to it, neither is it so destructive to animal life when transmitted into a recent wound as it is generally supposed to be. Were I disposed to speculate upon the manner in which it affects insects on being introduced by the fangs into their vascular system, I might conjecture that it has a tendency to paralyse their organs of voluntary motion, and to induce a determination of their fluids to the part injured; but I refrain from dwelling upon a suggestion, however plausible it may appear to be, which in the present state of our knowledge of the subject can only be regarded as hypothetical.

4. *Experiments on Inanimate Substances.*

In the month of September 1846, litmus paper presented to spiders belonging to several genera when in a state of extreme irritation, having their fangs extended, and the transparent fluid which issues from the fissure near their extremity conspicuously accumulated there, on being seized invariably became red as far as the fluid spread round the punctures made in it, a result clearly proving that this animal secretion, though tasteless, is an acid. Care, however, must be taken, in conducting the experiment, not to suffer any fluid from the mouth to blend with that which proceeds from the fangs, either before or after it has been transferred to the litmus paper, the former, rendering the blue colour of the test more intense, and restoring it after it has been converted to red by the action of acetous acid, being decidedly an alkali; consequently, if both combined in due proportions, they would neutralize each other; but as there is usually a much more copious supply of the alkaline than of the acid fluid, its agency would predominate, and scarcely a trace of red would be discerned on the litmus paper.

Submitted to the same chemical tests, the fluid contained in the stomachs of spiders and that which flows from wounds inflicted on their bodies and limbs were found to be alkaline. Now if the frequency and suddenness with which large quantities of fluid are propelled into the mouths of spiders when occupied in extracting nutriment from their prey be borne in mind, the conclusion that they must be ejected from the stomach through the narrow œsophagus and pharynx seems to be inevitable*, as there is not any other

* The statement of Savigny, that some spiders have three pharyngeal apertures, does not appear to be applicable to several of our larger indigenous species, as I have not been able to detect more than one such aperture in *Ciniflo ferox*, *Celotes saxatilis*, *Tegenaria civilis*, *Agelena labyrinthica* and *Epëira quadrata*, on the most careful inspection.

source known whence they could be derived; and it has been ascertained that if they are applied to litmus paper, which has or has not been reddened by acetous acid, they always produce upon it effects precisely similar to those caused by the gastric fluid, or rather by the fluid contents of the stomach, when subjected to such tests. I may remark that the yellow colour of turmeric paper is rendered brown by the application of the fluids from the mouth and stomach, and that it is restored again by the agency of the fluid secreted by the poison-glands, changes which afford another proof, in addition to those already advanced, of the respective alkaline and acid properties of these animal products.

The instruments employed by the *Araneidea* to seize and destroy their prey are improperly denominated mandibles; I say improperly, because they actually do not constitute any part of the oral apparatus, as Mr. W. S. MacLeay has plainly asserted*; indeed, many eminent zootomists, judging from their position and from the origin of the nerves distributed to them, entertain the highly probable opinion that they are the analogues of the antennæ of hexapod insects, and in accordance with this view of the subject M. Latreille termed them *chelicera*; but so widely do they differ from antennæ in structure and function, that the propriety of bestowing upon them a distinct appellation which does not imply anything hypothetical will scarcely be questioned: I propose, therefore, to name them *falces*.

Much of the misapprehension that exists among arachnologists relative to the *falces* has been occasioned, in all probability, either by the prevailing belief that spiders are destitute of a labrum, or by mistaken notions as to its precise situation. That they possess the organ in a low state of development is undeniable, as I have distinctly observed it in species belonging to the genera *Lycosa*, *Dolomedes*, *Salticus*, *Thomisus*, *Olios*, *Drassus*, *Clubiona*, *Ciniflo*, *Agelena*, *Tegenaria*, *Cælotes*, *Theridion*, *Linyphia*, *Epëira*, *Dysdera* and *Segestria* †. It is attached by its base to the superior surface of the palate, but the extremity, which is free and usually round or somewhat pointed, can be slightly elevated, depressed, extended, retracted and moved laterally at will. To apply the term mandibles to organs originating above the labrum, and therefore not situated within the mouth, must evidently be erroneous; and I venture to anticipate, upon anatomical considerations, that future investigations will lead to the conclusion that the mandibles of the *Araneidea* are confluent with the palate.

* Annals and Magazine of Natural History, vol. ii. p. 2, note*.

† Professor Owen has detected a rudimental labrum in spiders of the genus *Mygale*. See his 'Lectures on Comparative Anatomy,' Lecture XIX. Arachnida, p. 257.